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Affective Teacher–Student Relationships and Students' Engagement and Achievement: A Meta-Analytic Update and Test of the Mediating Role of Engagement

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Abstract. The present study took a meta-analytic approach to investigate whether students' engagement acts as a mediator in the association between affective teacher–student relationships and students' achievement. Furthermore, we examined whether results differed for primary and secondary school and whether similar results were found in a longitudinal subsample. Our sample consisted of 189 studies (249,198 students in total) that included students from preschool to high school. A distinction was made between positive relationship aspects (e.g., closeness) and negative relationship aspects (e.g., conflict). Meta-analytic structural equation modeling showed that, overall, the associations between both positive relationships and achievement and negative relationships and achievement were partially mediated by student engagement. Subsequent analyses revealed that mediation is applicable to both primary and secondary school. Only the direct association between positive relationships and engagement was stronger in secondary school than in primary school. Finally, partial mediation was also found in the longitudinal subsample.

It has been repeatedly suggested that the affective quality of dyadic teacher–student relationships influences students' engagement and achievement (e.g., Hamre & Pianta, 2001; Hughes, 2011). A previous meta-analysis provided support for these associations (Roorda, Koomen, Spilt, & Oort, 2011). As the last 5 years have seen an exponential increase in studies about this topic, we updated the previous meta-analytic sample with recent studies. Moreover, it has generally been assumed that the association between teacher–student relationships and academic achievement can be explained by students' engagement (Connell & Wellborn, 1991; Tucker et al., 2002). However, relatively few empirical studies have actually examined this mediating role of students' engagement, and available studies showed somewhat inconsistent results (e.g., Hughes, Luo, Kwok, & Loyd, 2008; Lam et al., 2012). In the present study, meta-analytic structural equation modeling (MASEM) was used, which enabled us to investigate the mediating role of engagement in a meta-analytic sample with studies that often did not test this mediating role themselves. Thus, the present study contributes to the field in several ways: First, it provides an update to a previous meta-analysis on teacher–student relationships, engagement, and achievement. Second, it allows conclusions about mediation by engagement based on a much larger number of studies than before. Third, because there are differences between primary and secondary school, both in the professional roles of teachers (Bergin & Bergin, 2009; Hargreaves, 2000) and methodological characteristics of studies (Roorda et al., 2011), we examine whether engagement similarly explains associations between affective teacher–student relationships and achievement across primary and secondary school. Finally, as our meta-analysis also includes a substantial number of longitudinal studies, we are able to investigate whether direct and indirect associations among teacher–student relationships, engagement, and achievement hold over

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time (i.e., are also found in a subsample with longitudinal studies only).

Theoretical Perspectives

Two theoretical approaches that have been especially important in research about teacher–student relationships in connection with academic adjustment are social–motivational theories and the extended attachment perspective (Davis, 2003). Both approaches assume that students' engagement plays an important role in explaining the impact of teacher–student relationships on students' achievement. Students' engagement is considered to be a multidimensional concept and can be defined as "the quality of a student's connection or involvement with the endeavor of schooling and hence with the people, activities, goals, values, and place that compose it" (Skinner, Kindermann, & Furrer, 2009, p. 494). Engagement thus includes different aspects that can be organized in three broad components (Fredricks, Blumenfeld, & Paris, 2004): behavioral engagement, which refers to students' participation in academics as well as social or extracurricular activities (e.g., effort, persistence, concentration); emotional engagement, which describes students' positive and negative feelings and reactions to academics, teachers, classmates, and school (e.g., enjoyment, satisfaction, boredom); and cognitive engagement, which refers to students' thoughtfulness and willingness to invest in the mastering of difficult skills and comprehension of complex ideas (e.g., self-regulation, cognitive strategy use). In most empirical studies, however, either these three components are not clearly distinguished or only one or two aspects of behavioral and/or emotional engagement are investigated. Therefore, we made no subdivisions and examined engagement as one multidimensional concept.

According to social–motivational theories (Connell & Wellborn, 1991; Deci, Vallerand, Pelletier, & Ryan, 1991), students will become engaged in schoolwork if their basic psychological needs for relatedness, competence, and autonomy are met. Teachers can fulfill these needs by respectively showing involvement (caring for and expressing interest in the student), providing structure (establishing clear rules and consequences), and supporting autonomy (giving students freedom to make their own choices). Students' higher engagement will, in turn, lead to higher grades and better performance on achievement tests (Skinner, Wellborn, & Connell, 1990). In this way, teachers' supportive behaviors affect students' achievement through their impact on students' engagement.

In the extended attachment perspective (Pianta, 1999; Verschueren & Koomen, 2012), the mediating role of engagement has been less explicitly hypothesized. A central idea in attachment theory is that teacher–student relationships that are characterized by high levels of closeness (i.e., the degree of warmth and openness in the relationship) and low levels of conflict (i.e., discordant and coercive interactions between teacher and student; Pianta, 2001) will help children feel emotionally secure. Emotional security, in turn, enables children's exploration of the learning environment and engagement in academic activities, which will result in better academic performance (Bergin & Bergin, 2009; Koomen, van Leeuwen, & van der Leij, 2004). In this way, teacher–student relationships influence school achievement through children's exploration of the environment and engagement in learning activities.

In the present meta-analysis, we focused on the affective quality of teacher–student relationships, or the emotional quality of interactions between teachers and students, as well as teachers' and students' feelings and beliefs about each other and their mutual relationship (Pianta, Hamre, & Stuhlman, 2003). We chose this focus because a previous meta-analysis showed that affective teacher behaviors (e.g., teacher empathy and teacher warmth) were more strongly associated with students' school outcomes than instructional teacher behaviors (e.g., encouragement of learning and higher order thinking; Cornelius-White, 2007). Likewise, previous studies found evidence that the affective dimension of social–motivational theory, teacher involvement, was a more salient predictor of students' engagement than teacher structure and autonomy support (e.g., Skinner & Belmont, 1993; Tucker et al., 2002). Furthermore, in the present study, we distinguished between positive relationships (e.g., closeness, involvement, relatedness, emotional support, warmth, and acceptance) and negative relationships (e.g., conflict, rejection, role strain, verbal abuse, and relational negativity). We made this distinction because studies conducted in primary schools have frequently reported that negative relationships (i.e., conflict) are more strongly associated with students' engagement and achievement than positive relationships (i.e., closeness; Baker, 2006; Hamre & Pianta, 2001).

Empirical Support for the Explanatory Role of Engagement

Although the mediating role of engagement has been generally assumed, relatively few empirical studies have actually investigated whether students' engagement acts as a mediator in the association between teacher–student relationships and students' academic achievement. Concerning the mediating role of engagement for positive relationships, Woolley, Kol, and Bowen (2009) showed that the association between teacher support and students' grades was mediated by students' satisfaction with school in a sample of Latino middle school students. Similarly, Zimmer-Gembeck, Chipuer, Hanisch, Creed, and McGregor (2006) reported that high school students' engagement mediated the link between teacher–student relationships and self-reported grades. In a sample of third-grade students, O'Connor and McCartney (2007) found that the association between teacher–student relationship quality and achievement test scores was only partially mediated by students' classroom engagement. Likewise, Lam et al. (2012) found that engagement partially mediated

the association between teacher support and performance in a sample of seventh to ninth graders from 12 different countries. With regard to negative relationships, de Bruyn (2005) found evidence that students' attentiveness fully mediated the link between teacher role strain (measured with items such as "Teachers don't seem to like me" and "Many teachers don't know me") and grade point average in a sample of first-year secondary school students.

Incidental longitudinal studies have also found evidence for the mediating role of engagement. In a 3-year longitudinal study with primary school students who were academically at risk due to their low literacy levels, Hughes et al. (2008) revealed that the association between teacher perceptions of positive relationship quality in Grade 1 and children's scores on both math and reading achievement tests in Grade 3 was fully mediated by engagement in Grade 2. In a follow-up study with the same sample, Hughes et al. found that engagement in Grade 4 also mediated the link between teacher–student conflict in Grade 3 and math and reading test scores in Grade 5 when students reported about relationship quality (Hughes, Wu, Kwok, Villarreal, & Johnson, 2012). Likewise, Kiuru et al. (2014) showed that the association between positive teacher affect in Grade 1 and academic performance in Grade 4 was fully mediated by task-focused behavior in Grades 2 and 3 in a sample of Finnish primary school children.

Although these studies provided evidence for the hypothesis that engagement mediates the association between teacher–student relationships and achievement, results are somewhat inconsistent. Some studies found evidence for full mediation (e.g., Hughes et al., 2008), whereas others only provided support for partial mediation (e.g., Lam et al., 2012). Furthermore, a large portion of the studies that measured teacher–student relationships, engagement, and achievement did not test the mediating role of engagement. Therefore, empirical evidence remains limited to a relatively small number of studies conducted in specific samples with specific age groups and measuring different aspects of engagement. In the present study, we used a large sample of studies ($k = 189$) to draw more substantiated conclusions about the mediating role of engagement.

Previous Meta-Analysis on Teacher–Student Relationships, Engagement, and Achievement

Results of a previous meta-analysis on affective teacher–student relationships, engagement, and achievement (Roorda et al., 2011) also gave rise to the assumption that engagement plays a mediating role; associations between teacher–student relationships and engagement were stronger than associations between teacher–student relationships and achievement (Roorda et al., 2011). The smaller effect sizes for teacher–student relationships and achievement seemed to suggest that associations were partly indirect (i.e., mediated by engagement). In the present study, we updated our meta-analytic sample and used more advanced statistical techniques (MASEM; Cheung & Chan, 2005; Jak, 2015; Jak, Oort, Roorda, & Koomen, 2013; Viswesvaran & Ones, 1995) to examine whether the smaller effect sizes for achievement were actually due to an indirect effect of teacher–student relationships through engagement. An advantage of this new technique is that indirect effects can be tested on a meta-analytic level, even if the original studies do not provide statistical information about indirect effects (Becker, 1992; Viswesvaran & Ones, 1995).

Differences Between Primary and Secondary School

There are considerable differences between primary school and secondary school. First, secondary school students usually have several teachers during the school day, whereas primary school students generally spend most of their time with the same teacher. Additionally, secondary schools are mostly larger than primary schools. Perhaps due to this scale difference, teacher–student relationships are usually less personal, less positive, and more distant in secondary schools than in primary schools (Bergin & Bergin, 2009; Hargreaves, 2000). These differences (i.e., less contact moments and more distant relationships between teachers and students) could imply that relationships with teachers are less important for the engagement and achievement of secondary school students than primary school children. This line of reasoning is supported by the general assumption made in the literature that secondary school students become increasingly independent from teachers and more focused on peers (e.g., Buhrmester & Furman, 1987; Hargreaves, 2000; Lynch & Cicchetti, 1997). However, it could also be argued that fewer contact moments and less positive bonds between teachers and students make secondary school students more sensitive to the degree of warmth and support they receive from their teachers, and hence, teacher–student relationships might be more important for secondary school students' engagement and achievement (cf., Roorda et al., 2011). Therefore, it is important to investigate the mediation models separately for primary and secondary school studies. Moreover, there are also methodological differences between primary and secondary school studies. Secondary school studies more often use student reports for both teacher–student relationships and engagement, as well as a cross-sectional design, and therefore some associations might be stronger in secondary school studies (Roorda et al., 2011).

The Present Study

In the present study, we first updated the literature search of a previous meta-analysis (Roorda et al., 2011). In this way, we were able to investigate whether associations among teacher–student relationships, engagement, and achievement would still hold if studies from the past 5 years were included. Second, we investigated whether students' engagement mediated the association between affective teacher–student relationships and academic achievement in the total sample of

studies. Third, we examined whether the mediational model applied to both primary and secondary school studies. Fourth, although most studies in our meta-analytic sample used a cross-sectional design, there was also a substantial number of longitudinal studies ($k = 52$), and we were therefore able to investigate whether the mediating role of engagement was found over time (i.e., in the longitudinal subsample only).

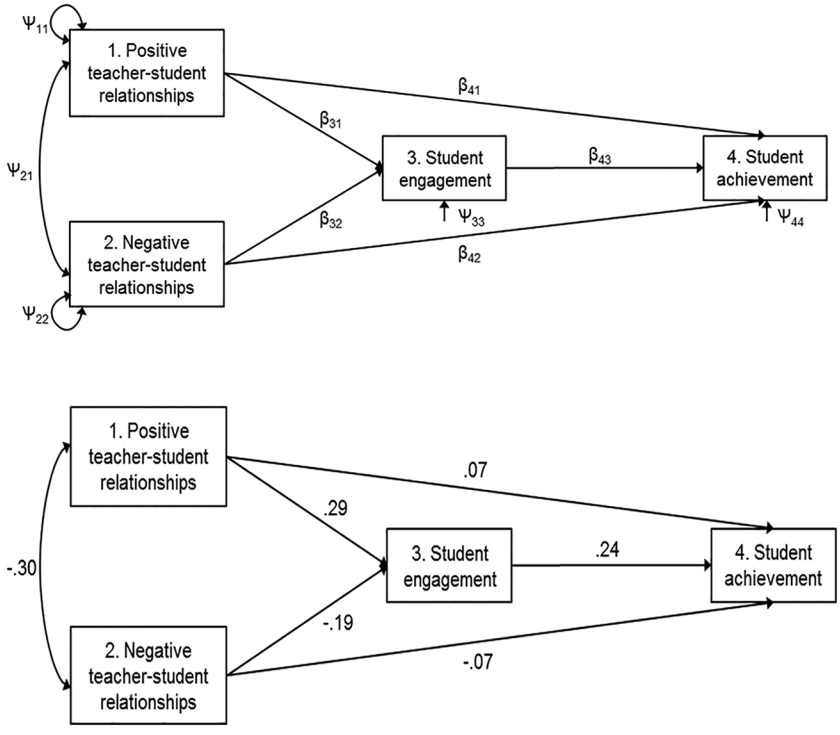
Figure 1a provides an overview of the hypothesized model. With regard to the direct effects, we hypothesized that positive relationships would be positively associated with students' engagement (β_{31} in the model; e.g., Murray & Zvoch, 2011; Tucker et al., 2002), whereas negative relationships would be negatively linked to engagement (β_{32}; e.g., de Laet et al., 2015; Murray, 2009). Furthermore, we expected that students' engagement would be positively associated with students' achievement (β_{43}; e.g., Chen & Gregory, 2009; You, Hong, & Ho, 2011). In addition, if direct effects could be identified, we hypothesized we would find positive associations between positive relationships and achievement (β_{41}; e.g., Murray & Zvoch, 2011; You et al., 2011) and negative associations between negative relationships and achievement (β_{42}; e.g., Al-Yagon & Mikulincer, 2004; Pianta, Nimetz, & Bennett, 1997). Finally, we expected to find indirect effects from both positive relationships through engagement on achievement ($\beta_{31} \times \beta_{43}$; Hughes et al., 2012; Kiuru et al., 2014) and from negative relationships through engagement on achievement ($\beta_{32} \times \beta_{43}$; de Bruyn, 2005). To summarize, we expected that engagement would mediate the association between both positive and negative relationships and students' achievement in the total sample of studies. However, as some previous studies found evidence for full mediation (e.g., Hughes et al., 2008) and others for partial mediation (e.g., Lam et al., 2012), we were not sure which to expect.

In the previous meta-analysis, associations between teacher–student relationships and engagement were stronger than associations between teacher–student relationships and achievement both in primary and secondary school studies. Therefore, we hypothesized that the mediating role of engagement would be applicable to both primary and secondary school. Still, associations between positive relationships and both engagement and achievement were stronger in secondary school studies, whereas associations between negative relationships and both engagement and achievement were stronger in primary school studies (Roorda et al., 2011). Therefore, associations with positive relationships were expected to be stronger in secondary school, whereas associations with negative relationships were anticipated to be stronger in primary school. Finally, we expected that the mediating role of engagement would also be found in the longitudinal subsample (e.g., Hughes et al., 2008; Kiuru et al., 2014) but that associations would probably be weaker than in the total sample of studies.

METHOD

In the present study, we used data from a previous meta-analysis (Roorda et al., 2011). In addition, we performed a new literature search to find studies that were published between 2009 and 2016. A description of this literature search

Figure 1. (a) Mediation Model With Parameter Labels and (b) Results for the Final Model for the Total Sample of Studies ($k = 189$)



can be found below. Furthermore, the inclusion and exclusion criteria that were used for the entire sample and the final meta-analytic sample will be discussed.

Literature Search

The PsycInfo and Educational Resources Information Center databases were used for the literature search. We only used keywords that yielded relevant studies in the previous literature search (Roorda et al., 2011). Hence, affective teacher–student relationships were represented by the following keywords: *relationship(s), closeness, support, relatedness, care/caring, conflict, neglect*, and *rejection*. Engagement was represented by *engagement, involvement, school adjustment, motivation, classroom participation, effort, persistence, school liking*, and *school avoidance*. Achievement was represented by *achievement, performance, learning*, and *development*. To limit the number of hits, additional keywords were entered in different combinations: *teacher-, student-, child-, academic-*, and *cognitive-*. We read titles, and if necessary abstracts and full texts, to determine whether articles were relevant to include in our analyses. We started our literature search in October 2015 and ended it in February 2016. Our literature search yielded a total of 1,090 new articles.

Inclusion and Exclusion Criteria

In the present study, we used the same inclusion and exclusion criteria as in the previous meta-analysis (Roorda et al., 2011), with one exception: Only studies published in peer-reviewed journals were included (cf., Lei, Cui, & Chiu, 2016; Nurmi, 2012). The following additional criteria were used to determine whether studies should be included in both the present and the previous meta-analysis: First, studies had to be reported in English and had to report sufficient statistical information to calculate at least one effect size that was relevant for the present study. Only studies with students from preschool through 12th grade were included. Teacher–student relationships had to be measured before or at the same time as engagement and achievement because the relationship was considered a predictor variable, whereas engagement and achievement were treated as dependent variables.

Further, studies had to measure the affective quality of the teacher–student relationship. In contrast, concepts like autonomy support, structure, instructional support, and academic support were not included because they are more closely related to behavior management and learning support than to the affective quality of the relationship. Studies in primary school have often used the Student–Teacher Relationship Scale (Pianta, 2001) to measure teachers' perceptions of the affective quality of the relationship (i.e., on the dimensions closeness and conflict; e.g., Baker, 2006; Palermo, Hanish, Martin, Fabes, & Reiser, 2007); in higher grades, studies have also frequently used student reports of, for example, teacher–student relatedness or teacher involvement (e.g., Skinner et al., 2009; Zhou, Lam, & Chan, 2012). Secondary school studies, in contrast, are more inclined to use student reports of the degree of teacher (emotional or social) support, measured with, for example, the Child and Adolescent Social Support Scale (e.g., Rueger, Malecki, & Demaray, 2010).

Teacher–student relationships had to be measured at the dyadic level (i.e., relationships between teachers and individual students). Studies measuring relationships at the group level were not included because previous research has shown that the affective quality of the teacher–student relationship differs across children in the same classroom (e.g., Hamre & Pianta, 2001). For instance, classroom climate measured with the Classroom Assessment Scoring System (e.g., Ponitz, Rimm-Kaufman, Grimm, & Curby, 2009) and teacher style measured with the Questionnaire on Teacher Interaction (see the review study of Wubbels & Brekelmans, 2005) were excluded for this reason.

With regard to students' engagement, participation in extracurricular activities (part of behavioral engagement) was not included because these activities are not primarily directed at academic learning. In addition, feelings and reactions to teachers and classmates (part of emotional engagement) were excluded because feelings and reactions to teachers are part of our independent variable (teacher–student relationships), and feelings and reactions to peers are typically considered predictors of engagement in literature (e.g., Malecki & Demaray, 2003; Wentzel, 1998). Examples of questionnaires that provided suitable measures of students' engagement and were included are the Engagement Versus Disaffection with Learning Questionnaire (e.g., Skinner et al., 2009) and the School Liking and Avoidance Questionnaire (e.g., Arbeau, Coplan, & Weeks, 2010). It should be noted that engagement can be measured at different levels. That is, a large number of studies measured students' engagement with school in general (e.g., Murray, Waas, & Murray, 2008; Wu, Hughes, & Kwok, 2010), others measured engagement with specific school subjects (e.g., Perry, Liu, & Pabian, 2010; Robinson & Fraser, 2013), and still others focused on engagement with specific tasks (e.g., Thijs & Koomen, 2008). In the present meta-analysis, we used a broad definition of engagement and included all of these levels.

With regard to academic achievement, the present meta-analysis only included students' actual performance. Academic self-concept (e.g., Olsson, 2009) or self-efficacy (e.g., Dorman, 2001) were not included because they reflect students' feelings and beliefs about themselves rather than their actual performance. To measure students' academic achievement, previous research has mostly used grades or test scores, whereas other studies used teacher reports, self-reported grades, or a combination of grades, tests, and questionnaires to measure performance. Furthermore, achievement has been measured in different subject areas, such as reading, math, science, and social studies. Many studies only included a composite measure of test scores or grades in different subject areas in their analyses, whereas others used, for example, teacher ratings for academic performance in general. Therefore, we did not distinguish between different subject areas in our meta-analysis. In cases in which the research did

make a distinction between performance in different subjects, we included these measures as a composite in our analyses.

Finally, studies had to measure teacher–student relationships, engagement, and achievement as separate concepts. Thus, studies that combined different concepts in one measure (e.g., engagement and achievement taken together as a more general concept of school adjustment) were not included. The examples given previously of questionnaires that provided acceptable measures of engagement also provided pure measures of teacher–student relationships. Some concepts represented different contents across studies. Affective engagement, for example, could be used as a synonym for emotional engagement and, hence, could be included. However, the concept could also encompass feelings toward peers and teachers (Estell & Perdue, 2013), in which case it was considered an impure concept. Concepts like school connectedness, school attachment, and school bonding sometimes referred to students' feelings and reactions toward school, and hence could be included as an indicator of engagement. In other studies, however, these concepts also included, or solely focused on, feelings toward peers or adults at school and/or feeling safe at school (e.g., Joyce & Early, 2014; Pham, McWhirter, & Murray, 2014) and thus had to be excluded as not providing a pure measure of engagement or relationships. In these instances, we based our decision to include or exclude a certain concept or study on the specific items used to measure the concept.

Multiple Effect Sizes Based on the Same Sample

For each association of interest, only one effect size could be included per sample, as inclusion of multiple effect sizes based on the same sample would violate the assumption of units of analysis (Lipsey & Wilson, 2001). Some samples, however, were used in multiple articles. For example, several articles used participants from the National Institute of Child Health and Human Development's Study of Early Child Care and Youth Development (e.g., Belsky et al., 2007; O'Connor & McCartney, 2007). In addition, some authors wrote more than one article about a single research sample (e.g., Hughes, 2011; Hughes et al., 2008). In the case of overlapping samples, we selected one article for each sample to be included based on the amount of information it provided, the sample size, and whether it measured associations longitudinally. More information about the specific articles that were selected in the case of overlapping samples and the underlying reasons are available upon request from the first author.

Some articles reported more than one effect size per association because they, for example, used different informants (e.g., teacher and child reports) or concepts (e.g., school liking and school avoidance; math and reading achievement) to measure teacher–student relationships, engagement, and/or achievement, or because they measured associations at different occasions. In these cases, all relevant effect sizes were averaged into one effect size per article.

Finally, some articles provided information about multiple studies using different samples (e.g., Bao & Lam, 2008), or studies provided separate effect sizes for different subgroups in their sample (e.g., for boys and girls in Hamre & Pianta, 2001; for kindergarten and first grade in Valeski & Stipek, 2001). In these instances, nonoverlapping subsamples were included as separate studies in the analyses. However, if these different groups of students were in the same classroom and shared the same teacher (e.g., the boys and girls in Hamre & Pianta, 2001), we averaged the effect sizes across groups and entered the study as a single study in the analyses.

Participants

After exclusion of articles that did not meet our inclusion criteria (951 articles) and after deletion of overlapping samples (33 articles), 106 new studies (k) reported in 103 articles remained to be included in our meta-analytic sample. As the present meta-analysis only included studies that were published in peer-reviewed journals, unpublished studies had to be deleted from the previous sample (e.g., dissertations, conference papers). In addition, some journal articles were deleted from the previous sample because they were based on the same sample as a new article. In total, 16 articles had to be excluded for these reasons, resulting in 76 articles (83 studies) that could be retained from the previous meta-analysis (Roorda et al., 2011). Our final sample thus consisted of 179 articles describing 189 studies from 1990 to 2016. In total, 249,198 students (N) were included in our analyses, with sample sizes varying from 42 to 39,553 students per study. Compared to the previous sample, more studies were conducted outside the United States ($k = 22$ in previous sample; $k = 78$ in present sample).

Our dataset contained 105 primary school studies (79,925 students in total) and 74 secondary school studies (107,473 students in total). Primary school studies covered preschool, kindergarten, and elementary school, whereas secondary school studies covered middle school, junior high school, and high school. Ten studies were not included in the separate analyses for primary versus secondary school because they contained students from both primary and secondary school or were not clear about whether their students were from primary school or middle/junior high school.

Analyses

We used the two-stage approach (Cheung & Chan, 2005) to fit the hypothesized model to the data. In the first stage, correlation matrices are combined to form a pooled correlation matrix. In the second stage, a structural model is fitted to this pooled correlation matrix. In Stage 1, the random effects approach is used as implemented in the R-package metaSEM (Cheung, 2014, 2015), which utilizes the OpenMx package (Boker et al., 2011) to pool the correlation coefficients. Random effects models account for heterogeneity across studies by assuming that studies have their own study-specific population correlation matrices. This leads to larger standard errors and confidence intervals for parameter

estimates than fixed-effects models (see Becker, 1992). The degree of heterogeneity is evaluated using the I^2 of the correlation coefficients (Higgins & Thompson, 2002). The I^2 can be interpreted as the percentage of total variance that is due to between-studies variability as opposed to (typical) within-study variability. In Stage 2, weighted least squares estimation is used to fit the hypothesized structural model (see Figure 1a) on the pooled correlation matrix from Stage 1, using the asymptotic covariance matrix of the Stage 1 estimates as the weight matrix. The structural model is a saturated model, which always fits the data perfectly (i.e., χ^2 [0] = 0.00, p = 1; CFI = 1.00; RMSEA = 0.00).

The significance of parameter estimates is evaluated with 95% likelihood-based confidence intervals (Neale & Miller, 1997). If the 95% confidence interval around a parameter estimate does not include zero, the parameter estimate is considered significant at a 5% level. Mediation was tested by evaluating the significance of the indirect effects of teacher–student relationships on student achievement. The indirect effects are equal to the product of the direct effects.

First, we evaluated the model for the total sample of studies. Second, we performed subgroup analyses and fitted the model separately to primary and secondary school studies. We tested whether the direct effects in the model differed significantly across school type by constraining effects to be equal across subgroups and using likelihood ratio tests for each effect in the model. Third, we fitted the model to the longitudinal subsample to see whether indirect and direct associations hold over time.

RESULTS

Effect sizes of the individual studies and corresponding references can be found in Table 1. Interpretation of the direct effects was based on the guidelines of Lipsey and Wilson (2001, p. 147). Coefficients less than .10 are considered as small, between .10 and .25 as small to medium, around .25 as medium, between .25 and .40 as medium to large, and greater than .40 as large. Indirect effects tend to be small, as they consist of the product of the direct effects. Previous studies investigating the mediating role of engagement usually found indirect effects varying between .01 and .08 (Kiuru et al., 2014; Lam et al., 2012; Zee, Koomen, & van der Veen, 2013).

Overall Model

Fitting the random effects model to pool the correlation coefficients across studies showed that there was substantial heterogeneity between studies, indicated by I^2 values above 92%. The random-effects model is thus the appropriate model. Table 2 shows the Stage 1 pooled correlation matrix. Table 3 displays the standardized parameter estimates with 95% confidence intervals from the Stage 2 model (see also Figure 1b). All direct effects in the model were significantly different from zero. Positive relationships had a positive, medium to large effect on engagement (β = .29), whereas negative relationships had a negative, small to medium effect on engagement (β = –.19). Engagement had a positive, medium effect on achievement (β = .24). The two indirect effects of positive and negative teacher–student relationships on achievement through engagement were small but significant (β = .07 and β = –.05, respectively), indicating mediation of these effects through engagement. As the direct effects of positive and negative relationships on achievement were also small but significant (β = .07 and β = –.07, respectively), there is partial mediation and no full mediation. The total effects can be calculated by summing the indirect and direct effects. The total effect of positive relationships on achievement was thus .07 + .07 = .14, meaning that one standard deviation increase in positive relationships is associated with a .14 standard deviation increase in achievement. The total effect of negative relationships on achievement was –.12, indicating that one standard deviation increase in negative relationships is associated with a .12 standard deviation decrease in achievement. The model explained 15% of the variance in engagement and 9% of the variance in achievement (calculated as 1 – residual variance). As some articles included more than one study or different independent samples (19 studies nested within nine articles), we also fitted the model taking this nesting into account. No differences were found between the models with and without correction for nesting.

Subgroup Analyses

In order to compare the coefficients across primary and secondary school studies, we created two subgroups of studies. The correlations could not be considered homogeneous within the primary school studies nor within secondary school studies with I^2 values above 85% for all correlation coefficients. The bottom portion of Table 2 displays the pooled correlations and I^2 values in the two subgroups.

We fitted the structural model to both groups. Next, we constrained the direct effects to be equal across groups, one by one. This led to a significant χ^2 difference for the effect of positive relationships on engagement, $\chi^2(1) = 6.16$, $p < .05$. The effect of positive relationships on engagement was stronger in secondary school samples (β = .32; i.e., medium to large effect) than in primary school samples (β = .24; i.e., medium effect). Constraining the other four effects to be equal did not lead to a significant deterioration of fit, $\chi^2(4) = 2.69$, $p = .61$, indicating that these effects can be considered equal across primary and secondary school studies. Table 4 shows the parameter estimates for both groups in the final model in which all effects, except the effect of positive relationships on engagement, were constrained to be equal across groups. For both primary and secondary school studies, all direct effects were significant and in the same direction as in the model for the total sample. Furthermore, the indirect effects from positive and negative relationships on achievement through engagement were also small but significant (β = .06 and .08 for positive relationships in primary

Table 1. Effect Sizes and Sample Size (*N*) for Individual Studies

Author	Year	Students (*N*)	p/s	r_{pe}	r_{ne}	r_{pa}	r_{na}	r_{pn}	r_{ea}
Allen & Fraser	2007	120	p	.11	–	.05	–	–	–
Al–Yagon & Mikulincer	2004	205	p	–	–	.19	–.33	–.38	–
Ang	2005	266	p	–	–	.22	–.03	–.45	–
Arbeau et al.	2010	169	p	.22	–.23	–	–	–.48	–
Archambault et al.	2013	1,145	p	.40	–	.17	–	–	.40
Baker	2006	1,310	p	–	–	.18	–.29	–.54	–
Bao & Lam	2008	48	p	.57	–	.16	–	–	.55
Bao & Lam	2008	99	p	.37	–	–	–	–	–
Barbarin et al.	2013	335	p	.25	–	.01	–	–	–
Birch & Ladd	1997	206	p	.35	–.26	–	–	–.73	–
Bos et al.	2008	866	s	–	–	.00	–	–	–
Brendgen et al.	2006	302	p	–	–	–	–.26	–	–
Buyse et al.	2009	6,994	p	–	–	–.01	–.03	–.20	–
Chan et al.	2013	526	–	.71	–	.10	–	–	.16
Chen & Astor	2010	3,058	s	–	–.49	–	–.13	–	.20
Chen & Astor	2011a	7,841	s	–	–.25	–	–	–	–
Chen & Astor	2011b	3,122	p	–	–.25	–	–	–	–
Chen & Gregory	2009	59	s	.28	–	.37	–	–	.79
Choi & Dobbs–Oates	2014	129	p	–	–	.13	–	–	–
Chong et al.	2010	523	s	.23	–.23	–	–	–.31	–
Close & Solberg	2008	427	s	.64	–	.29	–	–	.23
Commodari	2013	152	p	–	–	.18	–	–	–
Crosnoe et al.	2004	12,095	s	–	–	.23	–	–	–
Daly et al.	2009	123	s	.29	–	–	–	–	–
Daniels et al.	2001	66	p	.29	–	–	–	–	–
Davidson et al.	2010	383	s	.22	–	.27	–	–	.16
Davis	2001	82	p	–	–	–.03	–	–	–
Davis et al.	2010	333	s	–	–	.18	–	–	–
Davis & Lease	2007	344	s	.21	–	.27	–	–	–
de Bruyn	2005	749	s	–	–.23	–	–.19	–	.50
Decker et al.	2007	44	p	.22	–	–.06	–	–	.18
de Laet et al.	2015	586	p	.42	–.40	–	–	–.30	–
Demaray & Malecki	2002	125	s	.43	–	–	–	–	–
DeSantis King et al.	2006	974	s	.43	–	–	–	–	–
de Wit et al.	2010	2,616	s	.39	–	–	–	–	–
DiLalla et al.	2004	42	–	–	–	–.02	–.32	.23	–
Diseth et al.	2012	240	s	–	–	.28	–	–	–
Dorman	2009	4,407	s	.25	–	–	–	–	–
Dotterer & Lowe	2011	1,014	p	–	–.31	–	–.16	–	.16
Doumen et al.	2012	130	p	.33	–.27	–	–	–.32	–
Downer et al.	2010	145	p	.14	–.21	–	–	.06	–

Table 1. (Continued)

Author	Year	Students (*N*)	p/s	r_{pe}	r_{ne}	r_{pa}	r_{na}	r_{pn}	r_{ea}
Drugli	2013	825	p	–	–	.06	–.20	–	–
Elias & Haynes	2008	282	p	–	–	–.05	–	–	–
Engels et al.	2016	1,116	s	.28	–.24	–	–	–.25	–
Erkman et al.	2010	223	p	.35	–	.23	–	–	.12
Faircloth & Hamm	2005	5,530	s	.32	–	.33	–	–	–
Fauth et al.	2014	1,070	p	.14	–	.06	–	–	–
Federici & Skaalvik	2014	309	s	.22	–	.20	–	–	.38
Fraire et al.	2013	1,256	p	–	–	.32	–.25	–.35	–
Fryberg et al.	2013	90	s	–	–	.29	–	–	–
Furrer & Skinner	2003	641	p	–	–	.16	–	–	–
Galand & Hospel	2013	400	s	.43	–	–	–	–	–
Gallagher et al.	2013	199	p	–	–	.13	.15	.40	–
Garcia–Reid et al.	2005	226	s	.35	–	–	–	–	–
Garner & Waajid	2008	74	p	–	–	.31	–.25	–.11	–
Gehlbach et al.	2012	119	s	.23	–.12	.25	–.15	–.47	.16
Glozah & Pevalin	2014	770	s	–	–	.07	–	–	–
Gorman et al.	2002	351	s	–	–	.65	–	–	–
Gosse et al.	2014	360	p	–	–	.19	–.05	–.28	–
Graziano et al.	2007	73	p	–	–	.27	–	–	–
Gruman et al.	2008	1,003	p	.35	–	.01	–	–	–
Guvenc	2015	276	s	.50	–	–	–	–	–
Hallinan	2008	39,553	–	.31	–	–	–	–	–
Hamre & Pianta	2001	179	p	.22	–.45	.08	–.24	–	–
Harrison et al.	2007	125	p	.26	–.22	–.03	–.08	–.41	–.08
Helding & Fraser	2013	927	s	.47	–	.05	–	–	.04
Henricsson & Rydell	2006	91	p	–	–	.05	–.28	–	–
Honma & Uchiyama	2014	304	p	.13	–	–	–	–	–
Howes et al.	2008	1,806	p	–	–	.04	–	–	–
Huang	2009	10,682	s	–	–	.05	–	–	–
Hui & Sun	2010	760	p	.55	–	.29	–	–	–
Jen et al.	2013	3,901	s	.40	–	–	–	–	.15
Jia et al.	2009	706	s	–	–	.06	–	–	–
Jia et al.	2009	709	s	–	–	.11	–	–	–
Jiang et al.	2015	310	s	–	–	.12	–	–	–
Jimmieson et al.	2010	3,057	p	.57	–	–	–	–	–
Justice et al.	2008	133	p	–	–	.21	–.02	–.34	–
Kahn et al.	2010	362	s	–	–	.14	–	–	–
King	2015	848	s	.32	–	.26	–	–	.34
Kiuru et al.	2014	2,137	p	.21	–	.27	–	–	.17
Klem & Connell	2004	1,750	p	.22	–	–	–	–	–

(*Continued*)

Table 1. (Continued)

Author	Year	Students (*N*)	p/s	r_{pe}	r_{ne}	r_{pa}	r_{na}	r_{pn}	r_{ea}
Klem & Connell	2004	1,347	s	.18	–	–	–	–	–
Kong	2008	19,477	–	.64	–	–	–	–	–
Košir & Tement	2014	816	–	–	–	.29	–	–	–
Koul et al.	2011	1,027	s	.44	–	–	–	–	–
Ladd et al.	1999	200	p	.44	–	.33	–	–	.56
Ladd et al.	1999	199	p	.06	–.37	.24	–.18	–.45	.51
Ladd & Burgess	2001	385	p	.17	–.19	.09	–.14	–.31	.24
Lam et al.	2012	3,420	s	.48	–	.16	–	–	.24
Learner & Kruger	1997	150	s	.47	–	–	–	–	–
J. H. Lee	2015	1,777	s	–	–	–.11	.09	–.19	–
Lee & Bierman	2015	164	p	–	–	.27	–	–	–
S.-J. Lee	2007	318	s	–	–	.32	–	–	–
Liem et al.	2012	249	s	.47	–	.01	–	–	.05
Lietaert et al.	2015	385	s	.29	–	–	–	–	–
Liljeberg et al.	2011	788	s	.51	–.37	–	–	–.57	–
Ly et al.	2012	207	p	–	–	.09	–.10	–.25	–
Ma et al.	2009	774	p	.37	–	.32	–	–	.47
Makarova & Herzog	2013	1,186	p	.13	–	–	–	–	–
Makri–Botsari	2015	427	s	.38	–	.26	–	–	.38
Malecki & Demaray	2003	206	–	–	–	.32	–	–	–
Mantzicopoulos & Neuharth–Pritchett	2003	108	p	–	–	.06	–.27	.00	–
Mantzicopoulos & Neuharth–Pritchett	2003	123	p	–	–	.17	–.16	.00	–
Mantzicopoulos & Neuharth–Pritchett	2003	133	p	–	–	.10	–.24	.00	–
Martin & Marsh	2008	598	s	.58	–	–	–	–	–
Maurizi et al.	2013	202	s	.30	–	.32	–	–	.50
Mboya	1995	874	s	.23	–	–	–	–	–
McCombs et al.	2008	370	p	.33	–	–	–	–	–
McCombs et al.	2008	2,097	p	.20	–	–	–	–	–
McCormick et al.	2013	324	p	–	–	.08	–	–	–
Mercer & DeRosier	2008	1,193	p	–	–	.40	–	–	–
Murray	2009	104	s	.54	–.42	.13	–.25	–.36	.32
Murray & Greenberg	2000	170	p	.17	–.18	–	–	–.39	–
Murray et al.	2008	145	p	.18	–.22	–	–	–.55	–
Murray & Zvoch	2011	193	p	.42	–.21	.44	–.22	–.42	.37
Natvig et al.	2003	947	s	.43	–	–	–	–	–
NICHD network	2004	651	p	.07	–	–.02	–	–	–
Oades–Sese & Li	2011	468	p	–	–	.24	–.07	–.37	–
Palermo et al.	2007	95	p	–	–	.33	–.32	–.30	–
Pallock & Lamborn	2006	164	s	.43	–	.09	–	–	.20

Table 1. (Continued)

Author	Year	Students (*N*)	p/s	r_{pe}	r_{ne}	r_{pa}	r_{na}	r_{pn}	r_{ea}
Palsdottir et al.	2012	11,387	p	.36	–	–	–	–	–
Patrick et al.	2007	602	p	.53	–	.27	–	–	.28
Peisner–Feinberg et al.	2001	268	p	–	–	.08	–	–	–
Perry et al.	2010	285	s	.28	–	.17	–	–	.30
Pianta & Nimetz	1991	49	p	.14	–	–	–	–	–
Pianta et al.	1997	55	p	.34	–.33	.49	–.45	–	–
Portilla et al.	2014	338	p	.39	–.50	.13	–.12	–.27	.37
Raskauskas et al.	2010	1,168	p	.56	–	–	–	–	–
Rey et al.	2007	89	p	.31	–	.11	–	–.34	–
Rita & Martin–Dunlop	2011	261	s	–	–	.44	–	–	–
Robinson & Fraser	2013	172	p	.06	–	.29	–	–	–
Rowe et al.	2010	267	p	.38	–	–	–	–	–
Rowe et al.	2010	322	p	.58	–	–	–	–	–
Rueger et al.	2010	636	s	.28	–	.09	–	–	–
Ryan & Shim	2012	655	–	–	–	.09	–	–	–
Sakiz et al.	2012	317	s	.46	–	–	–	–	–
Schmitt et al.	2012	173	p	–	–	.37	–.02	–.17	–
Scrimin et al.	2014	205	–	–	–	.32	–	–	–
Searle et al.	2013	562	p	.25	–	–	–	–	–
Silva et al.	2011	722	p	.15	–.22	–	–	–.38	–
Skinner & Belmont	1993	144	p	.41	–	–	–	–	–
Skinner et al.	2009	1,018	p	.44	–.50	–	–	–	–
Skinner et al.	1990	220	p	.23	–	–.02	–	–	.41
Smit et al.	2014	230	s	.41	–	–	–	–	–
Somers et al.	2008	118	s	.46	–	.20	–	–	–
Spilt et al.	2015	4,983	p	–	–	.10	–	–	–
Stephanou	2014	200	p	.39	–	–	–	–	–
Stewart & Suldo	2011	390	s	–	–	.15	–	–	–
Stipek & Miles	2008	228	p	–	–.46	–	–.13	–	.35
Strøm et al.	2013	7,343	s	–	–	.19	–	–	–
Suldo et al.	2014	500	s	.14	–.10	.25	–.17	–	–
Tabbah et al.	2012	61	s	–	–	.34	–	–	–
Thijs & Koomen	2008	79	p	.56	–	–	–	–	–
Tiet et al.	2010	877	s	.23	–	.22	–	–	.35
Topor et al.	2010	158	p	–	–	.32	–	–	–
Trentacosta & Izard	2007	142	p	–	–	.20	–	–	–
Troop–Gordon & Kuntz	2013	352	p	.12	–.20	.24	–.17	–.29	.12
Tucker et al.	2002	96	–	.63	–	–	–	–	–
Tulviste & Rohner	2010	224	–	–	–	–.08	–	–	–
Ulriksen et al.	2015	8,574	s	–	–	.24	–	–	–

(*Continued*)

Table 1. (Continued)

Author	Year	Students (*N*)	p/s	r_{pe}	r_{ne}	r_{pa}	r_{na}	r_{pn}	r_{ea}
Urhahne	2015	246	s	.50	–	–	–	–	–
Valeski & Stipek	2001	225	p	.15	–	.06	–	–	.08
Valeski & Stipek	2001	127	p	.18	–	.04	–	–	.22
Valiente et al.	2008	264	p	.44	–	.32	–	–	.43
Valiente et al.	2012	291	p	.41	–	–	–	–	–
van Ryzin	2011	349	s	.48	–	.04	–	–	.15
Vedder et al.	2005	338	p	.12	–	–	–	–	–
Verkuyten & Thijs	2002	1,090	p	.33	–	.01	–	–	–
Viljaranta et al.	2015	156	p	–	–	–.11	–	–	–
Vitaro et al.	2012	446	p	–	–	–	–.24	–	–
Voisin et al.	2011	563	s	–	–	.02	–	–	–
Wang & Eccles	2013	1,157	s	.22	–	–	–	–	–
Wentzel	1997	248	s	.36	–	–	–	–	–
Wentzel	1998	167	s	–	–	.16	–	–	.27
Wentzel et al.	2010	358	s	.59	–	–	–	–	–
White	2013	127	p	–	–	.07	–.16	–.35	–
Williford et al.	2013	341	p	.15	–	–	–	–	–
Wolter et al.	2014	135	p	–	–	.19	–	–	–
Woolley et al.	2009	848	s	.58	–	.10	–	–	.06
Wu et al.	2010	706	p	.23	–.36	.07	–.21	–.35	.32
Wu et al.	2015	524	p	.16	–.13	–	–	–.11	–
Yang & Lamb	2014	67	p	.04	–.18	–	–	–.20	–
You et al.	2011	6,000	s	.56	–	.60	–	–	.59
Zee & de Bree	2017	370	p	.37	–.17	–.05	.02	–.49	.04
Zee et al.	2013	8,545	p	.31	–.09	.11	–.11	–.44	.08
Zhou et al.	2012	115	p	.54	–	–	–	–	–
Zhou et al.	2012	158	p	.42	–	–	–	–	–
Zimmer–Gembeck et al.	2006	324	s	.59	–	.35	–	–	.37
Zullig et al.	2011	2,049	s	.28	–	.14	–	–	.07

Note. p/s = primary or secondary school (p = primary school; s = secondary school); r_{pe} = correlation between positive relationships and engagement; r_{ne} = correlation between negative relationships and engagement; r_{pa} = correlation between positive relationships and achievement; r_{na} = correlation between negative relationships and achievement; r_{pn} = correlation between positive relationships and negative relationships; r_{ea} = correlation between engagement and achievement.

and secondary school studies, respectively; $\beta = -.05$ for negative relationships in both primary and secondary school). As the direct effects were also significant, there is partial, not full, mediation in both primary and secondary school studies. In the primary school studies, the model explained 13% of the variance in engagement and 9% of the variance in achievement. In the secondary school studies, the model explained 18% of the variance in engagement and 9% of the variance in achievement.

Longitudinal Studies

We also fitted the model to the studies with longitudinal effect sizes only (see Table 3; $k = 52$). Again, all direct effects were significantly different from zero and in the same direction as in the model for the total sample of studies. Contrary to the total sample, however, the direct effect of negative relationships on engagement ($\beta = -.23$; i.e., medium effect) was somewhat stronger than the direct effect of positive

Table 2. Stage 1: Pooled Correlations (and I^2) of the Research Variables in the Total Sample and Separately for Primary and Secondary School Studies

	1.	2.	3.	4.
Total sample				
1. Positive relationships	1			
2. Negative relationships	–.30 (98)	1		
3. Engagement	.35 (97)	–.28 (94)	1	
4. Achievement	.17 (96)	–.16 (92)	.28 (97)	1
Primary school studies (below the diagonal) and secondary school studies (above the diagonal)				
1. Positive relationships	1	–.35 (96)	.38 (96)	.20 (97)
2. Negative relationships	–.30 (97)	1	–.28 (95)	–.12 (94)
3. Engagement	.30 (94)	–.28 (90)	1	.29 (98)
4. Achievement	.15 (91)	–.16 (86)	.28 (95)	1

Table 3. Stage 2: Standardized Parameter Estimates (β) and 95% Confidence Intervals

Parameter	Complete sample	95% CI	Longitudinal subsample	95% CI
Direct effect, positive–engagement (β_{31})	.29	[.25, .32]	.16	[.11, .21]
Direct effect, negative–engagement (β_{32})	–.19	[–.24, –.15]	–.23	[–.29, –.17]
Direct effect, engagement–achievement (β_{43})	.24	[.18, .30]	.27	[.18, .36]
Direct effect, positive–achievement (β_{41})	.07	[.04, .11]	.07	[.02, .11]
Direct effect, negative–achievement (β_{42})	–.07	[–.11, –.02]	–.09	[–.15, –.03]
Indirect effect, positive–achievement ($\beta_{31} \times \beta_{43}$)	.07	[.05, .09]	.04	[.03, .07]
Indirect effect, negative–achievement ($\beta_{32} \times \beta_{43}$)	–.05	[–.06, –.03]	–.06	[–.09, –.04]
Correlation, positive and negative (ψ_{21})	–.30	[–.36, –.24]	–.34	[–.40, –.29]
Residual variance, engagement (Ψ_{33})	.85	[.82, .87]	.90	[.87, .92]
Residual variance, achievement (Ψ_{44})	.91	[.88, .93]	.89	[.84, .93]

Note. Variance, positive relationships (Ψ_{11}) and variance, negative relationships (Ψ_{22}) are equal to 1 by definition (because of analyzing a correlation matrix analysis). CI = confidence interval.

relationships on engagement (β = .16; i.e., small to medium effect). Just as in the total sample, indirect effects from positive and negative relationships through engagement on achievement were small but significant (β = .04 and β = –.06, respectively). Again, the direct effects of positive and negative relationships on achievement were also significant. Therefore, partial mediation, and not full mediation, was found in the longitudinal subsample.

DISCUSSION

In the present study, we updated the meta-analytic sample of Roorda et al. (2011) and investigated whether associations between affective teacher–student relationships and students' engagement and achievement still hold if recent studies are added to the analyses. Moreover, we used a new statistical technique (MASEM) to investigate whether students' engagement explains the association between affective teacher–student relationships and students' academic achievement. MASEM enabled us to investigate the explanatory role of engagement in a meta-analytic sample of 189 studies, in which most studies did not examine mediation themselves and did not report information about all relevant associations. Furthermore, we examined whether the explanatory role of engagement similarly applies to primary and secondary school and whether mediation would also be found in a subsample with only longitudinal studies.

Based on our results, we can draw the following conclusions. First, the previous meta-analysis (Roorda et al., 2011) showed that positive and negative aspects of the teacher–student relationship were significantly associated with students' engagement and achievement when associations were investigated in four separate models. The present study revealed that when all variables were included in the

Table 4. Standardized Parameter Estimates (β) and 95% Confidence Intervals in Primary and Secondary School Studies

Parameter	Primary	95% CI	Secondary	95% CI
Direct effect, positive–engagement (β_{31})	.24	[.20, .28]	.32	[.27, .36]
Direct effect, negative–engagement (β_{32})	–.20	[–.24, –.15]	–.20	[–.24, –.15]
Direct effect, engagement–achievement (β_{43})	.24	[.18, .30]	.24	[.18, .30]
Direct effect, positive–achievement (β_{41})	.07	[.03, .11]	.07	[.03, .11]
Direct effect, negative–achievement (β_{42})	–.07	[–.11, –.02]	–.07	[–.11, –.02]
Indirect effect, positive–achievement ($\beta_{31} \times \beta_{43}$)	.06	[.04, .08]	.08	[.06, .10]
Indirect effect, negative–achievement ($\beta_{32} \times \beta_{43}$)	–.05	[–.07, –.03]	–.05	[–.07, –.03]
Correlation, positive and negative (ψ_{21})	–.30	[–.37, –.24]	–.34	[–.45, –.23]
Residual variance, engagement (Ψ_{33})	.87	[.85, .90]	.82	[.79, .85]
Residual variance, achievement (Ψ_{44})	.91	[.88, .93]	.91	[.88, .93]

Note. Variance, positive relationships (Ψ_{11}) and variance, negative relationships (Ψ_{22}) are equal to 1 by definition (according to a correlation matrix analysis). CI = confidence interval.

same model and a larger sample of studies was used, the unique effects of positive and negative teacher–student relationships on students' engagement and achievement were still significant. Moreover, these unique effects were also significant when only longitudinal studies were considered. In this way, the present meta-analysis provides strong support for the association between both positive and negative aspects of the teacher–student relationship and students' engagement and achievement. Interestingly, when looking at the total sample of studies, the association between negative relationships and engagement was smaller than the association between positive relationships and engagement. In the longitudinal subsample, however, the association between negative relationships and engagement was stronger than the association between positive relationships and engagement (see Table 3). This might indicate a cumulative effect in which negative relationships and disengagement strengthen each other over time. Although more longitudinal research is needed to find out whether such cumulative effects actually exist, this finding may suggest that intervention in the development of negative teacher–student relationships is important in order to prevent a cascading effect of negative relationships.

Second and different from the previous meta-analysis (Roorda et al., 2011), most associations were the same for primary and secondary school. Thus, in contrast to the assumptions made in the literature (Buhrmester & Furman, 1987; Hargreaves, 2000; Lynch & Cicchetti, 1997), teacher–student relationships appear to be no less important for older students than for younger students. The association between positive relationships and engagement was even stronger in secondary school than in primary school. Perhaps positive relationships are more important for secondary school students' engagement because students tend to become naturally less engaged as they grow older (e.g., McDermott, Mordell, & Stoltzfus, 2001), making the quality of the relationship with teachers crucial for older students at greater academic risk due to their lower engagement (Hamre & Pianta, 2001).

Third, in line with previous studies (e.g., de Bruyn, 2005; Woolley et al., 2009), engagement mediated the association between teacher–student relationships and achievement. This mediation effect was found for both positive and negative teacher–student relationships, in both primary and secondary school studies, and in the longitudinal subsample. Although indirect effects were small, they are comparable to what was found in previous studies (e.g., Kiuru et al., 2014; Lam et al., 2012; Zee et al., 2013) and also appeared to hold over time. Thus, the assumed explanatory role of engagement (Connell & Wellborn, 1991; Tucker et al., 2002) seems to apply to students from different samples and from different age groups (i.e., from preschool to twelfth grade). In addition, the 189 studies in our meta-analysis used different operationalizations of engagement, teacher–student relationships, and achievement, which seems to suggest that the central role of engagement is not limited to the specific aspects of engagement, relationship quality, and achievement that were measured in the few previous studies that actually tested mediation.

Fourth, in contrast to Hughes et al. (2008), we found partial mediation instead of full mediation. Thus, in the total dataset, the subsamples of primary and secondary school studies, and the longitudinal subsample, teacher–student relationship quality also had a direct effect on students' achievement. This finding further emphasizes the importance of affective teacher–student relationships, as they did not only exert an indirect effect through engagement but also directly influenced students' achievement. It is possible, however, that the association between teacher–student relationships and achievement could be explained not only by engagement but also by other factors that were not examined in the present

study. For example, Garner and Waajid (2008) found that children's emotion knowledge also acted as a mediator in the association between teacher–student closeness and children's test scores. Likewise, Palermo et al. (2007) showed that the association between teacher–student conflict and academic readiness was mediated by children's prosocial and aggressive behavior and exclusion by the peer group. More research is needed to find out which factors other than engagement could explain the association between teacher–student relationships and achievement.

Qualifications and Suggestions for Future Research

Some qualifications need to be taken into account when interpreting the results of the present study. First, although we tested a causal model, most studies in our meta-analysis used a cross-sectional design. Therefore, strictly speaking, our data do not permit conclusions about causality. Moreover, some evidence has been found that associations might also be in the other direction, for example from engagement to teacher–student relationships (Skinner & Belmont, 1993). Still, findings from previous longitudinal studies (e.g., Hughes et al., 2008, 2012; Kiuru et al., 2014) as well as the results for the longitudinal subsample support the idea that the sequence from teacher–student relationships through engagement on achievement indeed occurs over time. More longitudinal research is needed to enable stronger conclusions about causality of influences.

Second, especially secondary school studies tended to use the same informant (i.e., student or teacher) for teacher–student relationships, engagement, and sometimes even achievement. Therefore, there is a risk that associations are inflated due to a shared informant and shared method variance (cf. Roorda et al., 2011). It is advisable to use multiple methods and multiple informants in future research.

Third, due to the current state of the field, we were not able to distinguish between the different components of engagement (i.e., behavioral versus emotional versus cognitive engagement). As both previous studies that measured behavioral engagement (e.g., Hughes et al., 2012) and studies that measured emotional engagement (e.g., Woolley et al., 2009) found evidence for the mediating role of engagement, our results most likely apply to all components of engagement. Still, it is possible that the strength of the (indirect) effects differs depending on the specific components of engagement under investigation (e.g., full mediation for behavioral engagement and only partial mediation for emotional engagement or vice versa). Therefore, future empirical research in which the different components of engagement are clearly distinguished is needed. We also were not able to distinguish between achievement and engagement in different school subjects. As Hughes et al. (2008) found that engagement mediated the association between teacher–student relationships and both math and reading achievement, engagement may play a central role regardless of which school subject is investigated. However, more research is needed to examine more accurately whether the mediating role of engagement also depends on subject area. This would also enable future meta-analyses to investigate possible differences in the mediating roles of behavioral, emotional, and cognitive engagement and between different subject areas.

Implications for Research and School Practice

Despite the limitations of the present meta-analysis, some implications can be formulated. The present study offers support for the assumption made in literature that students' engagement explains (part of) the association between teacher–student relationships and achievement and that these associations hold over time. Moreover, this role of engagement was found for both primary and secondary school studies. Therefore, attention to the mediating role of students' engagement would be profitable both for researchers interested in primary school students and researchers focusing on secondary school students. For example, it would be informative to investigate the mediating role of engagement over time more often, as a lot of studies still use a cross-sectional design. Furthermore, as there was only evidence for partial mediation, it might be beneficial to search for other possible mediators (cf., Garner & Waajid, 2008). Finally, as negative relationships appeared to be just as influential in secondary school studies as in primary school studies and only a few studies ($k = 10$) have actually investigated the role of negative relationships in secondary education, dedicating more attention to negative relationships, especially in secondary school, seems to be important.

With regard to school practice, the present meta-analysis provided renewed evidence for the importance of affective teacher–student relationships for students' academic achievement. Teacher–student relationships were not only indirectly associated with achievement through engagement, but direct effects were also found. Moreover, these associations extended into the longitudinal subsample and can hence be considered to persist over time. Therefore, teachers need to be made aware of the impact of the affective relationships they share with individual students. Although primary school teachers generally tend to have some basic notion about their own importance in their students' school adjustment, secondary school teachers usually feel that they are less important for their students and focus more on their instructional practices than on their emotionally supportive role (e.g., Hargreaves, 2000; Lynch & Cicchetti, 1997). The present meta-analysis, however, seems to suggest that affective teacher–student relationships are just as important for the engagement and achievement of secondary school students as for primary school students, and that positive relationships are even more important for secondary school students' engagement than for that of primary school students. Hence, it seems to be particularly important to help secondary school teachers become aware of their impact on their students' academic adjustment and help them improve their affective relationships with individual students. For instance, Check & Connect

(Christenson, Stout, & Pohl, 2012; Sinclair, Christenson, & Thurlow, 2005) is a promising intervention that focuses on relationship quality as a way to improve secondary school students' engagement. In addition, ideas and starting points from interventions with younger children, such as relationship-focused reflection (Spilt, Koomen, Thijs, & van der Leij, 2012) and interpersonal skills training (Roorda, Koomen, Thijs, & Oort, 2013), could probably be adapted for use in secondary school settings. However, as secondary school teachers generally have a lot of students to relate to and see most of them only for a few hours per week, time effectiveness is an important aspect that needs to be taken into account when developing intervention programs for secondary schools. One simple suggestion that could be implemented by teachers who see their students only a few hours per week is to actively invest time in learning the names of all their students, as this would be a first but important step toward making the students feel personally connected to the teacher and improving relationships with individual students.

Finally, due to the current state of the field, we were only able to draw conclusions about the role of engagement on a global level. That is, no distinction could be made between different components of engagement (i.e., behavioral, emotional, and cognitive engagement), between different levels of engagement (i.e., school in general, subject specific, or task specific), or between different school subjects. However, for school practice it would probably be most effective if interventions could be as specific as possible. For example, students might be disengaged emotionally but still show behavioral engagement or vice versa, or they might be disengaged only on the school level and not with regard to specific subjects. Therefore, knowledge about the ways in which the different components of engagement affect students' achievement and how each of them are influenced by teacher–student relationship quality is needed to help school practitioners develop more focused interventions to effectively improve students' achievement.

CONCLUSION

This meta-analytic review contributed to existing knowledge about the associations among teacher–student relationships, engagement, and achievement in several ways. First, we found evidence that affective relationships are associated with students' engagement and achievement in an updated and larger sample of studies as compared to the previous meta-analysis of Roorda et al. (2011). Second, with a meta-analytic sample of 189 studies, we were able to provide further evidence for the central role of engagement in explaining the link between teacher–student relationships and achievement. Third, as our meta-analytic sample included students from preschool to 12th grade, we were able to determine that the explanatory role of engagement was independent of students' age. Fourth, the mediating role of engagement appeared to hold over time, as it was also found in the longitudinal subsample. In this way, our findings confirm and extend evidence from previous studies (e.g., de Bruyn, 2005; Hughes et al., 2008; Kiuru et al., 2014) that students' engagement can be seen as a central factor in explaining the association between the affective quality of teacher–student relationships and students' academic achievement.

Nevertheless, in contrast to some previous studies (e.g., Hughes et al., 2008), we only found evidence for partial mediation and not for full mediation. This finding further emphasizes the importance of teacher–student relationship quality for the academic achievement of students from preschool to 12th grade, as relationship quality was both directly and indirectly connected with achievement, and these associations appeared to hold over time. With regard to school practice, this meta-analysis shows again that it is important for both primary and secondary school teachers to be aware of the impact of the affective relationships they share with individual students and to invest as much time and effort in these relationships as possible.

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